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ABSTRACT

Competitive bidding has recently received considerable attention in the literature of economics and operations research. Unfortunately, the classic formulation of the problem developed by Friedman and still expounded (Stark and Mayer) can lead to an incorrect estimate of the expected profit for a bidder when uncertainty about the cost of fulfilling the contract exists. The purpose of this paper is to point out the deficiency in the formulation and to indicate how it may be corrected. (Author)

UNCERTAIN COSTS IN COMPETITIVE BIDDING

by

Keith C. Brown

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UNCERTAIN COSTS IN COMPETITIVE BIDDING

Keith C. Brown*

Competitive bidding has recently received considerable attention in the literature of economics and operations research.[1] Unfortunately, the classic formulation of the problem developed by Friedman and still expounded (Stark and Mayer) can lead to an incorrect estimate of the expected profit for a bidder when uncertainty about the cost of fulfilling the contract exists. The purpose of this paper is to point out the deficiency in the formulation and to indicate how it may be corrected.

1. Statement of Bidding Problem

Suppose that someone who desires to purchase a specified collection of goods and services has asked for bids from potential suppliers. The bids will be collected and opened at some specified time and the contract awarded to the lowest bidder. The profit to the winning bidder will be the difference between the amount of his bid and the cost of fulfilling the contract.

Let C_i be this cost for i'th bidder, P_i be the amount bid, $\rho(P_i)$ the probability that a bid of amount P_i will win, and $\pi(P_i)$ be the expected profit which will result from a bid of amount P_i. Then

$$\pi(P_i) = (P_i - C_i)\ \rho(P_i). \quad (1)$$

If the i'th firm is an expected profit maximizer, then the problem

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[1]See, for example, Baron and the bibliography by Stark.

facing it is to choose that value of P_i which maximizes expected profits.

2. Uncertain Cost

The most usual situation, however, is that at the time the bid is prepared, the i'th firm does not know precisely what the cost of fulfilling the contract would be, but rather can only make an estimate of this cost, C_i'. But even if this estimate is unbiased, it is incorrect merely to substitute C_i' for C_i in (1), as Friedman and his successors have done.[2] Since each firm makes a bid based in part on its cost estimate, the smaller the cost estimate with respect to the true cost, ceteris paribus, the lower the bid the firm makes, the more likely it becomes the firm's bid will win, and the smaller the firm's actual profit will be if it does win.

This can be most clearly illustrated in the context of a perfectly symmetrical bidding situation in which each bidder will have the same cost (C) of fulfilling the contract, each firm has the same expected percentage accuracy in estimating this cost, each firm is aware of the precise number (n) of his competitors who will bid, and in which all firms have identical goals and information about their competitors. In such a case each bidder is mathematically indistinguishable from the others, and the equilibrium bidding strategies for all firms are identical.[3]

[2] I have committed a similar error in the context of competitive bidding for mineral rights. See Brown (1966, 1968, and 1969).

[3] See Rothkopf for an expanded version of this bidding context.

If this strategy is multiplicative, each firm takes its cost estimate C_i' and multiplies it by the same factor K in order to arrive at its bid. Thus, the firm which makes the lowest estimate wins.

The actual profit to the winning bidder will be $K\,C_i' - C$. The expected value of the profit to the winning bidder will be

$K\,C_i' - \left[C_i' + E(C - C_i')\right]$. Since $E(C - C_i')$ for the winning bidder is positive for many of the most plausible distributions of the cost estimates, then the expected profit to the winner may well be less than the difference between the amount bid and the firm's cost estimate. If the distribution of the cost estimates were known, it would be possible to calculate $E(C - C_i')$ using an elementary result of order statistics.[4] But since C is unknown by a firm when it submits its bid, typically this means that at least the location parameter of the distribution of cost estimates is unknown. If the dispersion of this distribution is not too large, however, an acceptable procedure may possibly be to use C_i' to estimate the location parameter so that the difference between the expected cost and the minimum estimated cost can be approximated.

In the non symmetrical bidding situation in which the firms may have differing actual costs, expected cost estimating accuracies, goals, information about competitors, etc., the expression for the winning

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[4] The cost estimate of the winning firm is the first order statistic of the cost estimates of the n firms which submit bids. If the distribution of the cost estimates is known, the mean value of the minimum estimate can be determined. See, for example, David.

firm's expected profit need be modified only slightly to $P_i - \left[C_i' + E(C_i - C_i')\right]$, where C_i is the actual cost the winning firm will incur. Finding $E(C_i - C_i')$ is more complex than in the symmetrical case. Not only do differing actual costs and estimating accuracies complicate the problem, but also, since different firms may rationally use different bidding strategies, the firm which makes the lowest cost estimate will not necessarily win. Nonctheless, the same sort of effect still obtains. Ceteris paribus, the probability that a given firm will win increases as its estimated cost decreases relative to its actual cost. Thus, the expected value of the difference between the winning bid and the winner's actual cost of fulfilling the contract will very likely be less than the expected value of the difference between the winning bid and the winner's cost estimate.

The magnitude of $E(C_i - C_i')$ as compared with $P_i - C_i$ is obviously dependent on the particular bidding scenario. It can, however, be astonishingly large if cost estimating accuracy is poor. Indeed, as Ewart has shown in a simulation study in a slightly different, but comparable context, under conditions of considerable uncertainty supposedly optimal bids derived from an uncorrected analog of equation (1) actually yielded negative expected profits.[5]

[5] Ewart simulated a perfectly symmetrical bidding situation for leases for undrilled petroleum lands. In this case, the profit to the winner (the high bidder) is the difference between the amount bid and the net present value of the lease. The uncertainty, of course, is about value of the untested tract. Ewart assumed that the value estimates were

random drawings from a lognormal distribution with mean equal to the logarithm of actual value and known variance. If V_i' equals the i'th firm's estimate of the value of the tract, then the analog to equation (1) for this situation is $\pi(P_i) = (V_i' - P_i)\,\rho\,(P_i)$. He determined an equilibrium strategy which maximized $E\left[\pi(P_i)\right]$ as defined by this equation. Then he simulated sealed bid auctions with varying numbers of participants and variances for the distribution of value estimates. He found that, ceteris paribus, as the variance of the value estimate distribution increased, the average difference between the apparently optimal bid and the actual tract value decreased, became zero, and then became increasingly negative. In this case, the firm with the highest value estimate submitted the highest bid and therefore won the auction. In terms of my argument above, the expected profit to the winning bidder should have been $V_i' + E(V_i - V_i') - P_i$.

REFERENCES

D. P. Baron, "Incentive Contracts and Competitive Bidding," American Economic Review, June 1972, 62, 384 - 394.

K. C. Brown, "A Theoretical and Statistical Study of Decision-Making Under Uncertainty: Competitive Bidding for Leases on Offshore Petroleum Lands," unpublished doctoral dissertation, Southern Methodist University, 1966.

K. C. Brown, "The Price Sensitivity of Petroleum Exploration: Comment," American Economic Review, March 1968, 58, 164 - 168.

K. C. Brown, Bidding for Offshore Oil: Toward an Optimal Strategy, Dallas, 1969.

H. A. David, Order Statistics, New York, 1970.

T. W. Ewart, "Bidding for Oil Leases: A Simulation Approach," unpublished doctoral dissertation, Purdue University, 1972.

L. Friedman, "A Competitive Bidding Strategy," Opns. Res., February 1956, 4, 104 - 112.

M. H. Rothkopf, "A Model of Rational Competitive Bidding," Mgmt. Sci., March 1969, 15, 362 - 373.

R. M. Stark, "Competitive Bidding: A Comprehensive Bibliography," Opns. Res., March/April 1971, 19, 484 - 490.

R. M. Stark and R. H. Mayer, "Some Multi-Contract Decision-Theoretic Competitive Bidding Models," Opns. Res., March/April 1971, 19, 469 - 483.

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